DOCUMENT RESUME

ED 233 011 SP 022 880

AUTHOR Miller, C[illegible]stine D.
TITLE A Comparison of Isotonic, Isokinetic, and Plyometric Training Methods for Vertical Jump Improvement.
PUB DATE Aug 83
NOTE 37p.; For related document, see ED 219 361.
PUB TYPE Information Analyses (070) -- Reference Materials - Bibliographies (131)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Athletic Coaches; *Athletics; Comparative Analysis; *Exercise Physiology; *Motor Reactions; Muscular Strength; Physical Education; Program Effectiveness; *Psychomotor Skills; *Training Methods
IDENTIFIERS Isokinetics; Isotonic Strength; Plyometric Exercise

ABSTRACT

This annotated bibliography documents three training methods used to develop vertical jumping ability and power: isotonic, isokinetics, and plyometric training. Research findings on all three forms of training are summarized and compared. A synthesis of conclusions drawn from the annotated writings is presented. The report includes a glossary of terms and an appendix with illustrations of various plyometric exercises. (JD)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED233011

A COMPARISON OF ISOTONIC, ISOKINETIC, AND PLYOMETRIC TRAINING METHODS FOR VERTICAL JUMP IMPROVEMENT

BY

CHRISTINE D. MILLER

Study Directed

by

Charles R. DuVall, Ph.D.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Christine D. Miller

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

✓ This document has been reproduced as received from the person or organization originating it.

Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

Submitted in partial fulfillment of the requirements
for the course E591---Exit Project
Indiana University at South Bend
August, 1983

SP 022 880

TABLE OF CONTENTS

	Page
INTRODUCTION	1
Statement of the Problem	3
Purpose of the Study	3
Organization of the Study	3
GLOSSARY	4
ANNOTATIONS	5
Isotonics	5
Isokinetics	10
Plyometrics	14
SUMMARY	21
CONCLUSIONS	24
BIBLIOGRAPHY	26
APPENDIX	30

INTRODUCTION

Athletic training methods have greatly advanced over the last decade. As athletes have improved, methods for more effective and efficient training have been sought to enhance further improvement. In the past, it was believed that to improve performance, an athlete simply had to develop his/her strength. Recently, however, research has indicated a need to develop strength specific to the sport (Prins, 28; Stevens, 22). In most cases, development of absolute strength is not needed or useful. Most sporting events require quick, explosive movement, which is developed through power training.

Power can best be described as the combination of strength and velocity. A muscle that can exert more power, can move a specific workload in a shorter amount of time. Power is a means of defining work.

In physical education, power is one of the component elements of motor fitness. Measuring the height of the vertical jump is one of the performance tests used to determine the degree of lower body power.

Lower body power training, and therefore, vertical jump improvement is not only important in physical education, but also in athletics. Training techniques, which provide significant vertical jump improvement in a short period of time, are of great importance to those involved in athletics (Copeland, 8). To jump higher, an athlete needs to be able to recruit as many muscle fibers as possible, at precisely the right time, with optimum strength of those particular muscle fibers (Riley, 189, 1979). The methods used need to bridge the gap between absolute strength development and power development to be of optimum benefit to the athlete.

This study will look at three methods used for vertical jump and lower body power improvement. The three methods are isotonic, isokinetic, and plyometric training.

Isotonics is a form of dynamic training, in which a muscle moves a specific workload through a prescribed range of motion. The usual form of resistance is with free weights or an isotonic weight machine. Isotonics require the muscle to use a concentric contraction to lift the weight, and an eccentric contraction to lower the weight. The workload used is limited to the maximum weight that can be moved at the muscle's weakest angle, usually at the beginning and end of the range of motion. Isotonic training is probably the most commonly used method.

Isokinetics, another form of dynamic training, requires a special apparatus. The apparatus allows a muscle to exert maximum effort through the full range of motion. As the muscle exerts more force, the apparatus produces more resistance equal to the force. The apparatus permits movement at a fixed rate of speed throughout the range of motion. This speed can be adjusted. Isokinetics requires only a concentric contraction, because there is no weight to be lowered.

Plyometric training has been used in the USSR and Eastern European countries for the past twenty years. It has just recently been gaining popularity in the United States. Plyometrics is based on the belief that forcefully lengthening a muscle (eccentric contraction) just prior to contraction (concentric contraction), will result in a more forceful contraction (Clutch, and others, 5). Forcefully stretching the muscle causes the myotatic reflex to prevent it from lengthening too far, creating tension, and causing more motor units to be stimulated. The training involves jumping from prescribed heights, skipping, hopping, and leaping. No special equipment is necessary.

STATEMENT OF THE PROBLEM

Various training methods have been used to improve vertical jumping ability, important in numerous athletic events, of athletes. To develop the vertical jumping ability, those in physical education and athletics, must evaluate training methods for their provision of maximum development of specific power (Jarver, 23). The method(s) chosen must achieve the required effect with a minimum of time and effort expended (Verhoshanski, 28). Three training methods, isotonic, isokinetic, and plyometric, will be evaluated for effectiveness and efficiency.

PURPOSE OF THE STUDY

The method(s) of power and jump training used can enhance or detract from an athlete's performance level. It is important for the training to develop optimum power in the least amount of time. Due to the specificity of training, a program must develop those muscles specifically involved in a particular sport. It is of major importance to physical educators, coaches, and athletes to use effective training procedures for the development of power in the lower body to increase the vertical jump.

ORGANIZATION OF THE STUDY

An annotated bibliography will be used to document three training methods used to develop vertical jumping ability and power: isotonic, isokinetic, and plyometric training. Definitions of terms will be given in a Glossary. There will be an Appendix with illustrations of various plyometric exercises.

GLOSSARY

Amortization - The gathering phase of a slack muscle during its lengthening.

Bounding - A form of plyometric training which includes hopping, skiping, and jumping.

Concentric Contraction - Overcoming or accelerating work; the muscle shortens as it moves a workload.

Depth Jump - A jump from a prescribed height with an immediate jump upon landing.

Eccentric Contraction - Yielding work; forced stretching of a muscle.

Full Range of Motion - The total range a muscle moves from complete extension to complete flexion.

Isokinetic - A form of training in which a machine must be used. This machine provides maximum resistance through the full range of motion at a specific velocity.

Isotonic - A form of training in which a specific workload is moved through the full range of motion.

Myotatic Reflex - A reflex by the muscle to resist overstretch.

Plyometric - "...an overload of isometric-type muscle action which invoke the stretch reflex in muscle." (Scoles, 48) Bounding drills and depth jumps are used for this type of training.

Power - Rate of work or force times velocity; it is composed of strength and speed.

Repetitions--Reps - The number of work intervals within one set.

Repetition Maximum--RM - The maximum weight that can be lifted for the indicated number of repetitions.

Set - A group of work intervals. The number of repetitions done consecutively, without a rest.

Specificity of Training - The training or developing of motion used specifically for the exact sports motion needed.

Vertical Jump - The ability to propel the body as high as possible.

ANNOTATIONS

VERTICAL JUMP TRAINING METHODS: ISOTONIC, ISOKINETIC, PLYOMETRIC

ISOTONIC

Bangerter, Blauer L., "Contributive Components in the Vertical Jump," The Research Quarterly, 39:432-436, October, 1968.

An isotonic progressive weight program was used to strengthen plantar flexors, knee extensors, and hip extensors to determine which of the three increased vertical jump ability the most. Four experimental groups and one control group were formed for the study. Group 1 exercised only the plantar flexor muscles, Group 2 only the knee extensor muscles, Group 3 only the hip extensor muscles, Group 4 exercised all three muscle groups, and Group 5 did no exercises.

The results indicated a significant improvement in the vertical jump for groups 2, 3, and 4. Group 1 did not even show a significant gain over the control group. It appeared that a progressive weight program to develop hip flexors and knee extensors was the most beneficial for vertical jump improvement.

Berger, Richard A., "Effects of Dynamic and Static Training on Vertical Jumping Ability," The Research Quarterly, 34:419-424, December, 1963.

The purpose of this study was to determine the effect of strength improvement on the vertical jump ability. If strength could improve performance, then static muscular training should have increased performance just as dynamic training did. Berger selected 89 college males who trained three times per week for seven weeks. Group 1 performed one set of 10 RM squats to approximately 90° and back to standing with a barbell on the shoulders. Group 2 performed one set of 10 jumping squats with weight on the shoulders equal to 50-60% 10 RM. Group 3 trained statically with one set of 10 maximum contractions for 6-8 seconds at approximately 90° and 135°. Group 4 performed 10 maximum vertical jumps. The results in the vertical jump showed Groups 1 and 2 improved significantly over Groups 3 and 4. Group 2 demonstrated more improvement than Group 1, but it was not enough to be significant. Berger concluded that dynamic overload training was more effective for increased vertical jump ability than static training. This could have been due, in part, to specificity of training. The movement of the legs in dynamic training was similar to the movement in the vertical jump.

Butler, Rick, High Performance Training for Volleyball, Training Publications, Inc., Glen Ellyn, IL., 1981, 117 pp.

Chapter 7 dealt primarily with resistance training specifically for volleyball. Butler pointed out that volleyball players had to develop the quadriceps, hamstrings, and gluteals to produce adequate power for effective jumping. It was also important for all exercises to be done within the range of motion a volleyball player used while jumping. The power training lasted approximately six weeks, with emphasis on quick, repetitive, explosive movements with resistance. Those exercises recommended were: calf raises with a barbell on the shoulders, doing 10-15 reps; squats with a barbell on the shoulders; thigh extensions, on a leg bench, doing 10 reps; and thigh flexion, on a bench, doing 10 reps.

Jaster, Sally, and Frazier, Charles S., "Developing Power Volleyball Power," The Athletic Journal, 58:32, 68-72, November, 1977.

This article stressed the need for the development of power for the vertical jump used in spiking and blocking. It stressed the necessity to develop superior leg strength for the frequently used power movements in volleyball. The authors pointed out that a specific program for muscular development was required, because simply participating in a game did little to contribute to muscular strength. Jaster and Frazier also stated that it was essential for a program to have proper supervision, be educationally sound, stress working through the full range of motion, individualization of the program, and not to overtrain the athlete.

They used both free weights and weight machines, using the barbell for developing the body core and the machines as a supplement. Much emphasis was placed upon developing superior leg strength because of the high degree of vertical jumping ability required. The exercises specifically for the leg muscles were the deadlift, squat, leg extension, hamstring curl, and leg press.

They gave a list of 16 principles to be followed for a successful weight training program. Those that were more important were the number of days to exercise, the number of repetitions and sets, the amount of weight to be used, and the amount of rest between exercises.

McKethan, J. F., and Mayhew, J. L., "Effects of Isometrics, Isotonics, and Combined Isometrics--Isotonics on Quadriceps Strength and Vertical Jump," The Journal of Sports Medicine and Physical Fitness, 14:224-228, September, 1974.

This study compared three methods of training for strength and vertical jump improvement. The three groups had approximately the same number of subjects, and trained twice a week for nine weeks. The isotonic group performed leg extensions for three sets of six RM. The isometric group did three maximal contractions for six seconds on each leg at 90°, 110°, and 130°. The isometric--isotonic group used an Exer-genie, which permitted an isometric contraction at 90°, followed by an isotonic contraction for three reps.

The findings concluded that even though there were significant strength gains in all subjects, there was no significant change in vertical jump performance. This led the researchers to conclude that different neuromuscular patterns were involved in dynamic strength such as the vertical jump, and that training should resemble the performance movements.

Pickens, Boyd, "Weight Lifting and Basketball," The Basketball Clinic, 13:13-15, December, 1980.

Pickens stated that basketball had progressed to a degree where strength and power were essential for a player. Only weight lifting produced the desired outcomes for the athlete, especially for the vertical jump improvement. Lifting had to be done three times per week on a regular basis using large amounts of weight for three sets, with low repetitions (8-10) to develop power and quickness. It was also important for the athlete to set attainable goals, keep records of progress, compete with him/herself or a partner, and to concentrate while lifting to avoid horseplay.

He gave a list of terms used for his weight training program which helped define some of the exercises he gave. The isotonic exercises used to develop power in the lower body were deadlifts, squats (regular, tension, ten-second, ten-second front), toe raises (regular, ten-second), leg presses, leg extensions, leg curls.

Raveling, George, War on the Boards a Rebounding Manual, n. pub., n. d., 75 pp.

Raveling used an isotonic weight program to develop power needed in explosive movements such as the vertical jump. The weight program lasted approximately four weeks, and was administered in conjunction with a conditioning program. The body was divided into five segments, and five exercises were performed with as many repetitions as possible in one minute, with two minutes rest between exercises. Those exercises specifically for the legs were the half squat and deadlift, with the beginning weight approximately three-fourths of the athlete's body weight. The remaining three exercises were the curl, sit-ups, and military press. At the conclusion of the workout, each participant calculated a "Power Index". This indicated the total amount lifted per minute, per pound of body weight. This was calculated in such a way as to have eliminated the influence of an athlete's body weight, making everyone equal. This provided a highly competitive atmosphere.

Riley, Dan, "Time and Intensity Keys to Maximum Strength Gains," Scholastic Coach, 50:64, 66, 74-75, November, 1980.

This article dealt with two important aspects of isotonic weight training--time and intensity. It was essential for an athlete to exercise muscles the correct length of time and at a high level of intensity to attain optimum results. To develop power the concentric contraction had to last 1-2 seconds, and the eccentric contraction four seconds, making the total duration 5-6 seconds. To develop the lower body muscles, the particular exercise being performed had to last 70-150 seconds. Less than 70 seconds was not intense enough to develop proper endurance and more than 150 seconds made it aerobic in nature. When isolating a lower body muscle in an exercise, such as leg extensions or hip flexions, there had to be 12-15 reps, and 20-30 reps when several muscle groups were used in exercises such as squats or leg presses. It was important to remember that muscles did not recognize repetitions, but only the length of time and the intensity of the workout. It was stated that coaches should concern themselves with the amount of time each isolated muscle was exercised as well as the large muscle groups. Training took place 2-3 days per week, allowing at least one day rest for the muscles to recover. Four to six lower body exercises designed to include all muscles, and performed at a high intensity, were all that were needed for optimum results.

Riley, Daniel, "Strength Training for Volleyball," in Championship Volleyball by the Experts, pp. 189-204, Edited by Bob Bertucci, Leisure Press, West Point, N.Y., 1979.

Riley explained that due to the specificity of muscles, to improve vertical jumping ability one had to develop those muscles specifically involved in jumping through a weight training program. The program had to improve the neuromuscular efficiency and strength of those specific muscles involved to increase the vertical jump. He stated that when designing a program, those techniques used should create maximum gains in the least amount of time. For the program to be efficient and effective, he had established seven training variables to be followed: the number of repetitions needed, the workload, the number of sets, the recovery time, the frequency of the workouts, the order in which the body segments should be worked, and the number of different exercises to be performed. He also explained the importance of the quality of the exercises and listed five checkpoints that ensured proper performance.

Silvester, L. Jay, and others, "The Effect of Variable Resistance and Free--Weight Training Programs on Strength and Vertical Jump," National Strength and Conditioning Association Journal, 3:30-33, December/January, 1981-82.

One of the purposes of this study was to compare a program of free weight exercises with programs of variable resistance exercises and their effect on the development of power and the vertical jump. Three groups of male college students trained three days per week for 11 weeks. Group 1 trained on a Nautilus Compound Leg Machine, performing both leg extension and leg press to failure. Group 2 trained on a Universal Variable Resistance Maximum Overload Leg Press Machine, and performed one set of 7-10 repetitions and one set to failure. Group 3 performed box squats with an Olympic barbell, and performed three sets of six repetitions, taking three seconds to complete one repetition. The subject squated to a bench adjusted to his height, and upon making contact returned to standing. All three groups performed the same upper body exercises. The free weight training group improved the most in the vertical jump, the Universal group had the second best results, and the Nautilus group showed very little improvement.

Wathen, Dan, "A Comparison of the Effects of Selected Isotonic and Isokinetic Exercises, Modalities, and Programs on Vertical Jump in College Football Players," National Strength and Conditioning Association Journal, 2:46-47, October/November, 1980.

The purpose of this study was to investigate possible differences in the use of isokinetic equipment and isotonic equipment and the effect on the vertical jump ability of athletes. Fifty-two college football players were divided into an isotonic group and an isokinetic group. Both groups trained three times per week for eight weeks, and did the same flexibility, strength, and running program. The isokinetic group trained on a Mini-Gym Leaper, doing five sets of 20 repetitions at the fastest setting on the apparatus. The isotonic group performed barbell squats, doing five sets of 7, 5, 3, 3, 8 repetitions. At the completion of the eight weeks, both groups were retested in the vertical jump. While some individuals in the isokinetic group improved as much as 3-6 inches, the group had not showed any significant gains. On the other hand, the isotonic group had improved significantly. He concluded that due to fatigue, many of the athletes had not worked at maximum intensity on the isokinetic equipment. Less effort brought about less resistance by the machine. He also thought that perhaps the machine may not have been able to offer maximum resistance at maximum speeds. Even though the isotonic group worked with large amounts of weight, with low repetition, and slow speed of movement, there were more muscle motor units required to move the weight. He therefore concluded, the more training of more motor units produced greater power.

ISOKINETICS

Copeland, Dolores Ann, The Effects of an Isokinetic Power Training Program for Women on Vertical Jumping Ability, Unpublished doctor's thesis, School of Physical Education, State University of Iowa, July, 1977, 63 pp., Typed. Sports Information and Recreation Centre, Ottawa, Ontario, Canada.

In the mid-1960's isokinetics was introduced as a method of rehabilitation. No matter how strong or weak a limb was, the isokinetic apparatus provided resistance equal to the amount of force exerted. A fixed speed was maintained throughout the range of motion. As isokinetics developed, the area of athletics began to utilize it for training.

The purpose of this study was to test the effect of isokinetically trained lower limb extensors on the vertical jump. The subjects were female college students in physical education classes. They were initially divided into two groups according to their vertical jump. The low jumping was 10½ inches to 12½ inches, and the high jumping was 14 inches to 18 inches. They were further randomly divided into control low jumping, experimental low jumping, control high jumping, and experimental high jumping groups. The experimental groups trained three days per week for five weeks. Each session they performed three sets of eight repetitions at a speed setting of 250°/second. The speed setting was selected because it was comparable to the speed of the performance task (vertical jump). The knee angle and the ankle angle were 90°. The control group did no training, and neither group did any other form of training.

After five weeks, the experimental low jumping group showed significantly higher vertical jump scores than the control low jumping group. The experimental high jumping group did not show significant gains over control high jumping group.

Kousakin, A. N., "Isokinetic Exercises," Yessis Review of Soviet Physical Education and Sports, 9:1-6, March, 1974.

Kousakin explained the concept of isokinetic apparatus providing resistance that directly correlated with the force applied, and that speed remained relatively constant as maximum load was applied to the full range of motion. This resulted in higher demands upon the muscles than with other accepted methods of strength development. He compared isometric, isotonic, and isokinetic exercise and pointed out the limitations of each. He listed the following basic advantages of isokinetic exercise: greater quality of the workout, decreased pain due to muscle soreness, decreased workout time, specificity of training was accomplished due to various speed settings, and increased strength.

Kusakin, A., "A New Method of Strength Preparation," Yessis Review of Soviet Physical Education and Sports, 6:107-109, December, 1971.

This article was a general discussion about isokinetic exercise. He stated that isokinetics developed dynamic strength, assured maximum load throughout the full range of motion, and maintained an even speed. He also explained that with increased force of execution the isokinetic machine provided more resistance. The more dynamic effort applied, the more resistance produced by the apparatus. He also noted the constant speed maintained by an isokinetic machine was probably its main shortcoming. Most sports movement occurred with acceleration or uneven, jerky movement.

Miller, Carl, "Isokinetics Another Fad or is it Here to Stay?," The Athletic Journal, 55:20, 74-75, November, 1974.

According to Miller, true isokinetics varied perfectly with an individual's skeletal leverage and fatigued muscles. Resistance was always in direct proportion to effort, accomplished with a pre-set speed device that remained constant no matter what the effort. The isokinetic machine was reported to have eliminated the ballistic action during which the bone moved so fast the muscle slackened and did no work. The example he gave was the leg extension with isotonic weight. There was so much force at the beginning to move the weight that ballistic action took over. The muscle only worked at the beginning and end of the extension.

Miller pointed out several advantages: recovery was faster and more complete with no muscle soreness (due to lack of negative resistance--eccentric contraction), workout time was reduced, speed control could be used for fast or slow workouts, and there was maximum resistance through the range of motion.

Pipes, Thomas V., and Wilmore, Jack H., "Muscular Strength Through Isotonic and Isokinetic Resistance Training," The Athletic Journal, 56:42-45, June, 1976.

It was noted that strength gains were specific to the exercies performed and the method of training used. An athlete used those methods that met his/her particular needs. Isotonics and isometrics were the two most commonly used training methods, but both had disadvantages. Isometrics were very specific to the angle trained at and the isotonic load remained constant through the range of motion, which caused the muscle to contract at various percentages rather than maximum.

Isokinetics were lauded the best way to train, because it allowed for variable resistance and maximum tension through the full range of motion. It also allowed limb speed movement of 0°-200°/second, whereas isotonic exercise rarely exceeded 60°/second. This was sighted as an important aspect of the specificity of training, since most limb speeds in athletics vary from 90°/second to several hundred degrees per second.

They conducted an experiment to examine the differences between isotonic and isokinetic training and its effects on muscular strength, body composition, and athletic performance. One of the motor tests used was the vertical jump. All three training groups performed the bench press, biceps curl, leg press, and bent row, three days per week for eight weeks. The isotonic group performed three sets of eight reps at 75% 1 RM. One isokinetic group performed three sets of eight reps at a 24°/second limb speed and the other performed three sets of 15 reps at a 136°/second limb speed. They found that isokinetic training significantly improved all areas of the study far more than isotonic training. It was not stated if there was any significant difference between the two speeds for vertical jump improvement.

Prins, Jan, "A Physiological Review of Leg Extensor Power and Jumping Ability," Swimming World and Junior Swimmer, 21:28-30, 32, November, 1980.

Prins defined power as the rate of doing work. A muscle produced more power if it moved a specific workload in a shorter amount of time. Leg extension power and vertical jumping ability were clearly related. Therefore, the most widely accepted test for leg power in physical education was the Sargent's Jump Test. He discussed the relationship of a higher percentage of fast twitch (white) fibers being present in subjects with better vertical jump scores. This theory was believed true by many experts, but he concluded there was no significant correlation. He suggested, after testing female volleyball players, that neuromuscular efficiency was more responsible for better jumping than muscle size or strength.

He conducted a study using an isokinetic Mini-Gymn Leaper. Five subjects trained at a fast speed, 130°/second, and five subjects at a slow speed, 35°/second, four times per week for ten weeks. The results showed a significant vertical jump increase for the fast speed group, while the slow speed group actually decreased. He concluded that since exercising at the faster speed improved jumping ability, accelerated movement for power training was essential.

Stevens, Ron, "Isokinetic vs. Isotonic Training in the Development of Lower Body Strength and Power," in Isokinetic Research, pp. 22-23, MGI Strength/Fitness Systems, Independence, MO., 1980.

A study was conducted to compare isokinetic and isotonic effects on development of body strength and power. Seventy-five male high school students were randomly divided into three groups and trained three days per week for eight weeks. Group A performed the parallel squat with free weights and did five sets of five reps on a light, moderate, heavy system. Group B used the isokinetic Thrust machine and performed four sets of ten repetitions at a moderate speed the first four weeks and a fast speed the last four weeks. Group C performed the same exercises as Group B for two days per week and heavy load squats one day per week. The results indiciated Group B made the greatest gains in the vertical jump with an average increase of 2.72 inches per subject.

In the discussion that followed, Stevens noted that power was a combination of strength and speed, and it was very important for most athletes to train for power rather than absolute strength. Power training provided strength gains while improving the explosiveness of the muscles at the same time. It was noted that power training more readily met the demands of athletics since quick, explosive movements were needed.

Van Oteghen, Sharon L., "Two Speeds of Isokinetic Exercise as Related to the Vertical Jump Performance in Women," The Research Quarterly, 46:78-84, March, 1975.

Van Oteghen explained that isokinetics provided maximum resistance throughout the range of motion of a muscle and maintained the same speed throughout the exercise. During the mid-range of the muscle movement, where it exerted more force, the isokinetic machine offered more resistance than at the opposite extremes of the range of motion, where the muscle required less resistance. This study of isokinetic training was conducted to determine the effectiveness of training at a slow speed (four seconds to complete one repetition) and a fast speed (two seconds to complete one repetition), and vertical jump improvement. Van Oteghen randomly selected 48 female volleyball players from four universities. There were 16 subjects in each group of control, fast speed and slow speed. Both training groups performed three sets of ten RM leg presses, three days per week for eight weeks. The results indicated no significant difference in the vertical jump performance between the two isokinetically trained groups. However, the isokinetic groups were significantly superior to the control group, which did no training.

Wilson, Jim, "Isokinetics for Maxi-Programs" The Athletic Journal, 53:39, 91-92, April, 1973.

Wilson supported the idea that weight training was an essential part of the high school athletic program. He found that isokinetic apparatus provided the best method of training for the athletes he trained. He discussed the disadvantages of isometric and isotonic training. He felt isokinetics had very few disadvantages, and many advantages. The advantages were less workout time, lack of sore muscles, no weight changes, and no loose equipment lying around.

His training program was conducted three days per week. The athlete did a few warm-up exercises and jogged, then performed two sets for 30 seconds doing as many repetitions as possible at 12 stations, and one set to fatigue at four stations. The isokinetic exercises used specifically for the legs were leg extension, leg curl, squat thrust, squat, and military press.

PLYOMETRICS

Blattner, Stuart E., and Noble, Larry, "Relative Effects of Isokinetic and Plyometric Training on Vertical Jumping Performance," The Research Quarterly, 50:583-588, December, 1979.

This study compared the effects of plyometric and isokinetic training on the vertical jump. Forty-eight male subjects were divided into an isokinetic exercise group, a plyometric exercise group, and a control group. Both of the training groups worked out three times per week for eight weeks. The plyometric group performed depth jumps from a 34" high platform and did three sets of ten repetitions. Beginning week three, a weighted vest was worn weighing ten pounds; week five, fifteen pounds, and week 7, twenty pounds. The isokinetic group performed three sets of ten repetitions on a Mini-Gym Leaper with the movement speed set as fast as possible (1.47'/sec.). Each repetition was completed as rapidly as possible with maximum effort.

Mean gains were 1.94" for the isokinetic group and 2.05" for the plyometric group. Neither training procedure was more effective for improving the vertical jump. Both methods significantly improved the vertical jump over the control group whose mean gain was .28". Plyometrics was proven to be an effective method for vertical jump improvement and much more inexpensive than isokinetics.

Butler, Rick, High Performance Training for Volleyball, Training Publications, Inc., Glen Ellyn, IL, 1981, 117 pp.

This chapter dealt with plyometric jump training methods. Butler explained that teaching athletes proper landing (eccentric phase) techniques of jumping to reduce the possibility of injury was important. The jumping exercises he gave were very successful in developing explosive jumping ability in volleyball players. The only equipment required were two folding mats, a football tackling-blocking bag, and an adjustable platform to jump from. The following were exercises listed for vertical jump improvement: Box jumps: from a blocking position the athlete jumped onto the box and back to the floor; Box approaches: the athlete used a spike approach and jumped onto the box; Box jumps over bag: the box and bag were about four feet apart and the athlete jumped over the bag and upon landing exploded up onto the box; Repeat box jumping: from a blocking position the athlete jumped on top of the box, jumped off making a 180° turn in the air, and upon landing exploded back up on top of the box; Box hops: the bags were about two feet apart and the athlete jumped sideways over the bags. Sets and repetitions varied according to the cycle the athlete was in.

Clutch, David, and others, "The Effect of Depth Jumps and Weight Training on Leg Strength and Vertical Jump," The Research Quarterly for Exercise and Sport, 54:5-10, March, 1983.

This article gave a good definition and simple explanation of plyometric principles. It also gave a good background on previous studies on plyometrics and the effect on the vertical jump.

The first experiment used a college weight lifting class for subjects, and divided it into three training groups: maximum vertical jumps, 0.3 meter (approx. 15") depth jumps, and 0.75 meter (approx. 30") and 1.10 meter (approx. 42") depth jumps. All three groups lifted weights three weeks prior to jump training and throughout the training program. All groups performed four sets of ten repetitions. The maximum vertical jump group jumped from a stationary position and paused after each jump so as not to cause a bounding effect. The 0.3 m depth jump group stepped off a box and upon landing immediately jumped as quickly and as high as possible. The 0.75 m-1.10 m group performed two sets from each height and executed the jumps as the 0.3 m group had. They found all three forms of training elicited vertical jump gains. They concluded that almost any jump training program, when combined with strength training, would produce vertical jump improvement.

The researchers thought perhaps plyometric training was beneficial only to trained athletes, so they conducted a second experiment in which a volleyball team and a weight lifting class were randomly assigned to one of two groups. Both groups performed the same weight lifting exercises, but one group also did four sets of ten repetition depth jumps from 0.75 m and 1.10 m twice per week. The results indicated the volleyball players involved in depth jumping had vertical jump increases equal to those players who only lifted weights and did routine jumping during practice. However, the weight lifters who did no jump training demonstrated very little increase. The researchers concluded that plyometric training was not superior to any other form of jump training program.

Fritzsche, Gunter, "Leg Power Exercises for Young Athletes," in The Jumps: Contemporary Theory, Technique & Training, pp. 19-22, TAFNEW Press, Los Altos, CA., 1981.

Fritzche explained that jump training programs for young athletes had to be individualized and developed according to the biological needs of the athlete. The program had to have variety and stress power development rather than absolute strength. The body was still developing at that age (10-13) and high intensity weight lifting and training could cause injury. He divided jump training into two categories: ability and power. Jumping ability was developed by using various jumping exercises to total 150-220 repetitions in a 15-20 minute workout. Jumping power was developed by using various jumping exercises to total 80-100 repetitions in a 20-25 minute session. All the exercises he gave were plyometric and were used as relays or in games to make the training session more interesting and fun for the young athlete.

Jarver, Jess, "Specific Power in Jumping," in The Jumps: Contemporary Theory, Technique & Training, pp. 23-26, Edited by Jess Jarver, TAFNEW Press, Los Altos, CA., 1981.

The article was a summary of the concept of plyometric training methods used to develop jumping power. He explained that by pre-stretching a muscle in one direction a stronger muscle contraction may occur in the opposite direction. This was due to the kinetic energy built-up during the amortization phase (eccentric contraction). The kinetic energy was produced by the muscle trying to stop the stretching action in one direction and contract (shorten) in the opposite direction. The action that changed the muscles from stretching to a concentric contraction was called the myotatic reflex. Laboratory tests proved that muscle groups could achieve higher level contractions, creating maximum power, when amortization phase occurred. He than gave depth jumping exercises to develop jumping power.

Johnson, Carl. "Bounding for All," The Jumps: Contemporary Theory, Technique & Training, pp. 16-18, Edited by Jess Jarver, TAFNEW Press, Los Altos, CA., 1981.

This article was a description of jump training exercises using plyometrics. Johnson supported the theory that white muscle fibers (fast twitch) had to be developed to produce optimum power. He contended that plyometric training best accomplished this. He also covered the physiological aspect of eccentric (yielding work) and concentric (accelerating work) contraction. He explained that during eccentric contraction the muscles stretched and built up kinetic energy. This stretching triggered the myotatic reflex to stop the stretching phase and reverse the direction of the muscle. Plyometric training was purported to develop that neuromuscular response, creating a faster transfer from eccentric to concentric contraction, and more efficiently use the kinetic energy. This in turn produced more power and better jumping ability.

Lefroy, C. E., "Jump Training," in Championship Volleyball by the Experts, pp. 204-206, Edited by Bob Bertucci, Leisure Press, West Point, N.Y., 1979.

Lefroy stated that jump training procedures had to duplicate the movements and conditions under which an athlete would be jumping to improve the vertical jump. To accomplish this all the jump training had to be performed with maximum effort and every jump done quickly. Due to the intensity of maximum jumping Lefroy suggested that several jump training sessions take place throughout a practice. Each session consisted of approximately five sets of 5-15 seconds duration with up to one minute rests between sets. The exercises he gave were all plyometric in nature: rebound jumping or depth jumping, high skipping with a rope, jump sideways, forward, or backward over a rope 4-6 inches below maximum vertical jump, hop-step-hop, chair jumping, and leap frog.

Mann, Ron, "A Plyometric Progression to Meet the Athlete's Needs," Scholastic Coach, 51:51-52, 55, September, 1981.

This article explained two aspects of plyometric training. First, the stretch reflex caused a muscle to contract almost as soon as it was stretched. The time it took for the reflex to occur was most important for the vertical jump. He explained that the reaction time could be decreased through plyometric training. Secondly, stored elastic energy enabled the muscles to contract more strongly when it had been rapidly stretched. Plyometric drills developed the stretching condition and strengthened the muscles.

He then outlined a training routine for beginners, intermediate, and advanced athletes. All three groups did depth jumping, bounding, and jogging. The beginners only had one session a week, the intermediates and advanced two sessions per week. As the program progressed from beginning to advanced, the workout session became more rigorous.

Polhemus, Russ, "Plyometric Training for the Improvement of Athletic Ability," Scholastic Coach, 51:68-69, November, 1981.

Polhemus stated that plyometric training was based on the theory that when a muscle was forced to lengthen very quickly there was greater tension produced within the muscle. The tension was produced by the stretch reflex trying to prevent the muscle from stretching too far. The use of plyometrics trained the central nervous system to work at a higher rate and stimulate more muscle fibers which resulted in greater force. In this study, three groups performed a conventional weight training program. Two of the three groups also did plyometric training with one group adding ankle and vest weights. The training was done three days per week for six weeks, with the two plyometric groups training immediately after lifting weights. The plyometric drills consisted of running with high knee lifts for five sets of 30 seconds; depth jumping from an 18 inch bench and back up to the bench for three sets of ten reps; and bounding, with maximum jumps, across a 30 foot floor for three sets of three reps. The group which performed the plyometric exercises with weights increased the vertical jump dramatically over the other two groups.

Scoles, Gordon, "Depth Jumping! Does it Really Work?," The Athletic Journal, 58:48, 50, 74-76, January, 1978.

Scoles explained that depth jumping was purported to bridge the gap between strength and power. This was accomplished by performing depth jumps--jumping from a prescribed height, landing, and immediately jumping up as fast and as high as possible. Depth jumping stretched the muscles involved very rapidly, producing tension, which in turn produced a stronger contraction of the muscle.

He conducted an experiment on a college physical education class to determine the effect of depth jumping on the vertical jump. The class was divided into three groups: depth jumping, flexibility, and control. Both training groups trained twice per week for eight weeks. The control did no training. The depth jump group performed 20 repetitions from 0.75 meters, and the flexibility group did stretching exercises for the hamstrings, quadriceps, and lower back. The results of the tests indicated no significant gains in the vertical jump for any of the groups. However, test scores for the depth jump group showed more mean gain improvement than either of the other two.

He explained his results were due to various limitations of the study. He still supported the use of plyometrics for developing power needed for the vertical jump.

Verhoshanski, Yuri, "Are Depth Jumps Useful?," Yessis Review of Soviet Physical Education and Sports, 3:75-78, September, 1968.

This article explained the theory behind the use of depth jumping to improve vertical jumping. He explained that as an athlete became more proficient at jumping he/she required less knee bend and more quickly extended the legs due to neuromuscular development of switching from the eccentric to the concentric contraction. The best way to develop the fast transfer was to use depth jumping. Depth jumping was done by standing on a platform at a prescribed height, jumping off, and upon landing immediately jumping up as fast and high as possible. The depth jumping was done from a 0.75 meter height and a 1.10 meter height for optimum results. The 0.75 m height developed the fast switching from eccentric to concentric contraction and the 1.10 m height developed dynamic strength. Any height greater than 1.10 m decreased the positive effect of depth jumping. He emphasized that a depth jumping program had to be gradual. Beginners jumped once per week for 20-30 repetitions and worked up to twice per week for 40 repetitions doing two sets of ten repetitions at each height. Between sets, the athlete jogged and did relaxation exercises.

Verkhoshanski, Yuri, "Perspectives in the Improvement of Speed-Strength Preparation of Jumpers," Yessis Review of Soviet Physical Education and Sports, 4:28-34, June, 1969.

Verkhoshanski stated that over the years jump training had relied heavily upon weight training until finally the amount of exercise required of athletes took away from actually jumping. He also believed that exercise should be designed to correlate with the movements that took place during the sport event. The effectiveness of a jump was directly related to how much dynamic effort could be produced in the least amount of time--power. He further explained that as an athlete involved in sports requiring vertical jumping becomes a master, he/she had to do less weight lifting and more training of the muscles to switch from eccentric to concentric contraction as quickly as possible. He contended that too much weight lifting slowed down the muscle-nerve reaction time. He felt the only way to develop the reaction, and thus increase vertical jump, was the bounding exercises and depth jumping. Weight lifting was used only as a supplement. He also gave a program of exercises to be done as an athlete progressed in skill level.

Wilt, Fred, "Plyometrics What is it--How it Works," The Athletic Journal, 55:76, 89, May, 1975.

This article was a good explanation of plyometric exercise. He explained that when a muscle was forced to lengthen (eccentric contraction) rapidly more tension was produced and a stronger shortening (concentric contraction) of the muscle occurred. The rate at which the muscle was stretched was more important than how far it was stretched, because the faster it stretched the more tension it built up. Plyometric exercise trained the eccentric aspect of the muscles by stimulating the neuromuscular motor units (myotatic reflex) to prevent overstretching, which resulted in a stronger concentric contraction.

Yessis, Michael, "Maximize Your Basketball Players' Jumping Abilities," The Winning Edge, 1:1-2, 10, May-June, 1981.

Due to the fast pace of basketball, it was important for an athlete to develop the ability to quickly change horizontal momentum into vertical momentum. The transferring was most effectively accomplished with strong eccentric strength. Eccentric strength prevented the knee from flexing too far and absorbing the momentum. Tension had to be generated in the muscle during the eccentric phase to produce force. The degree of tension and the faster the change from eccentric to concentric contraction occurred determined how much force there would be to jump.

He prescribed four isotonic leg exercises to develop strength and to help develop eccentric strength by lowering the weight slowly. His main method of jump training was the use of depth jumps. The athlete began by jumping off a one foot high bench without rebounding up and progressed to a higher platform with the rebound. The development of the quick transfer from eccentric to concentric contraction was developed by hopping, skipping, and leaping over 20-30 yards with quick, explosive movements. After several months of this training, the athlete was ready to progress to full depth jumps from a height of 30-40 inches and 2-3 sets of 5-8 repetitions twice per week. Jumping ability was not simply attributable to strength, but to the ability of the neuromuscular units to switch from eccentric to concentric contraction quickly. Plyometric training provided the best method for its development.

SUMMARY

Research indicated all three forms of training were effective methods for vertical jump improvement. One method did not appear to be superior to either of the other two. Wathen, Silvester, and others, compared isotonic weight training to isokinetic training and found the isotonic program produced higher gains in vertical jump performance. On the other hand, Pipes and Wilmore conducted a similar study and found the opposite to be true. Blattner and Noble concluded that both plyometrics and isokinetics were effective for producing vertical jump improvement, and neither was superior to the other. Clutch, and others also concluded that while plyometrics improved vertical jump ability, it was not superior to any other form of jump training.

Each method required training two to three times per week on a regular basis. One day of rest between sessions was advocated for all three. This was to allow the muscles to properly recover. It was also important that overtraining did not occur during a workout session. According to Riley, coaches needed to be aware of the amount of time each individual muscle was worked during a workout.

Riley, Verhoshanski, and Pipes and Wilmore all agreed that the training program used by an athlete needed to be specific to the movements in the particular sport. Power training needed to take place in those muscles involved in the vertical jump. And, according to Wathen, the training of more motor units produced more power. A good example would be the study by Berger. The group which performed jumping squats with a barbell on the shoulders, improved vertical jump performance more than the other three. Limb speeds during sports vary from ninety degrees per second to several hundred degrees per second. Therefore, Verhoshanski,

Copeland, and Pipes and Wilmore all agreed the speed of execution during training needed to correspond with the execution during the actual performance in a sport.

There was conflicting evidence of the importance of eccentric contraction for training purposes. Both isotonic and plyometric training used eccentric as well as concentric contraction. Isokinetics used only concentric contraction.

Developing the eccentric contraction was the essence of plyometric training. Only by developing that form of contraction, along with the neuromuscular response of the myotatic reflex, could vertical jump be improved. The eccentric contraction was developed with depth jumping, hopping, skipping, and leaping activities, all done with rapid, explosive movements.

Isotonic exercise also required eccentric contraction during the lowering of the workload. Yessis and Riley believed that to develop power, the workload needed to be lowered slowly, about four seconds. This would develop eccentric strength and power.

According to Kousakin and Miller, one of the main advantages of isokinetic training was the absence of eccentric contraction. That helped prevent muscle soreness, because the blood could flow more freely through muscles. It allowed the blood to carry away waste products and supply oxygenated blood to the working muscles.

In all the training procedures, two to four sets of a particular exercise was normally prescribed. However, the number of repetitions varied. Raveling advocated performing as many repetitions as possible in one minute, Riley preferred twenty to thirty, and McKethan and Mayhew prescribed six for isotonic exercise. Repetitions for isokinetic training ranged from eight, prescribed by Copeland, to as many as possible in thirty

seconds by Wilson. Plyometrics was the most consistant, with eight to ten repetitions the normal amount.

One of the main goals in jump training was the efficiency of producing vertical jump improvement. According to Riley, a program had to be designed to produce maximum gains in a minimum amount of time. Apparently, all three training methods produced results in a relatively short period of time. The studies and programs ranged in length from one to three months.

CONCLUSIONS

It was concluded that any one of the methods could be used for a program of vertical jump improvement. The method chosen depended upon the facilities available and the preference of the coach or athlete. The only way to improve vertical jump ability was to develop power in those muscles used in jumping. The quadricep, hamstring, buttock, and calf muscles all needed to be included in the training.

An isotonic program included box squats, squat jumps, one-legged squats, forward lunges, leg extensions, leg curls, deadlifts, leg presses, and toe raises. Each exercise was performed in three sets of twelve to fifteen repetitions. Each concentric contraction lasted two seconds, and each eccentric contraction four seconds. The workload was such, that failure was reached in the fifteenth repetition. Upon completion of one exercise, the next exercise was begun immediately. The workout sessions were three days per week, with one day rest between sessions. A pre-season program lasted four to six weeks. Lifting during the season was cut back to two days per week.

An isokinetic program involved a great deal of expense to purchase the special equipment needed. The most used piece of apparatus in most programs was the Mini-Gym Leaper. However, Mini-Gym also produced a Ham-Quad unit, Thigh Extension unit, and Leg Press unit that proved useful for a well rounded program.

The isokinetic workout sessions were performed three days per week on alternate days. Four sets of ten repetitions were performed at the fastest setting on the apparatus. The rest period between sets was approximately two minutes. It was important for each repetition to be performed with maximum effort. Due to the lack of muscle soreness and the

quick recovery time, isokinetics was used with the same intensity throughout the season.

Plyometrics involved depth jumping, hopping, leaping, and skipping with or without added resistance from ankle or vest weights. The depth jumps were performed from two feet six inches and three feet six inches to produce optimum results. The two feet six inches developed the quick switching from eccentric to concentric work, and the three feet six inches developed dynamic strength. Upon landing from one of the prescribed heights, the athlete immediately jumped as high as possible. Two sets of eight to ten repetitions were performed from each height, with light jogging and stretching exercises between sets. Bounding exercises of leaps, hops, and skips were done over a distance of fifteen to twenty yards, with high, quick, explosive movements. Three to five sets of three to five repetitions were used for the bounding drills. These drills were done on one or two legs, and obstacles were added to jump over. Plyometric sessions were only done two times per week. Along with the plyometric exercises it was best to conduct a weight training program for a good strength base.

BIBLIOGRAPHY

BIBLIOGRAPHY

Bangerter, Blauer L., "Contributive Components in the Vertical Jump," The Research Quarterly, 39:432-436, October, 1968.

Berger, Richard A., "Effects of Dynamic and Static Training on Vertical Jumping Ability," The Research Quarterly, 34:419-424, December, 1963.

Blattner, Stuart E., and Noble, Larry, "Relative Effects of Isokinetic and Plyometric Training on Vertical Jumping Performance," The Research Quarterly, 50:583-588, December, 1979.

Butler, Rick, High Performance Training for Volleyball, Training Publications, Inc., Glen Ellyn, IL., 1981, 117 pp.

Clutch, David, and others, "The Effect of Depth Jumps and Weight Training on Leg Strength and Vertical Jump," The Research Quarterly for Exercise and Sport, 54:5-10, March, 1983. (2)

Copeland, Dolores Ann, The Effects of an Isokinetic Power Training Program for Women on Vertical Jumping Ability, Unpublished doctor's thesis, School of Physical Education, State University of Iowa, July, 1977, 63 pp., Typed. Sports Information and Recreation Centre, Ottawa, Ontario, Canada. (1)

Fritzsche, Gunter, "Leg Power Exercises for Young Athletes," in The Jumps: Contemporary Theory, Technique & Training, pp. 19-22, TAFNEW Press, Loss Altos, CA., 1981.

Jarver, Jess, "Specific Power in Jumping," in The Jumps: Contemporary Theory, Technique & Training, pp. 23-26, Edited by Jess Jarver, TAFNEW Press, Los Altos, CA., 1981. (3)

Jaster, Sally, and Frazier, Charles S., "Developing Power Volleyball Power," The Athletic Journal, 58:32, 68-72, November, 1977.

Johnson, Carl, "Bounding for All," The Jumps: Contemporary Theory, Technique & Training, pp. 16-18, Edited by Jess Jarver, TAFNEW Press, Los Altos, CA., 1981.

Kousakin, A. N., "Isokinetic Exercises," Yessis Review of Soviet Physical Education and Sports, 9:1-6, March, 1974.

Kusakin, A., "A New Method of Strength Preparation," Yessis Review of Soviet Physical Education and Sports, 6:107-109, December, 1971.

Lefroy, C. E., "Jump Training," in Championship Volleyball by the Experts, pp. 204-206, Edited by Bob Bertucci, Leisure Press, West Point, N.Y., 1979.

Mann, Ron, "A Plyometric Progression to Meet the Athlete's Needs," Scholastic Coach, 51:51-52, 55, September, 1981.

McKethan, J. F., and Mayhew, J. L., "Effects of Isometrics, Isotonics, and Combined Isometrics--Isotonics on Quadriceps Strength and Vertical Jump," The Journal of Sports Medicine and Physical Fitness, 14:224-228, September, 1974.

Miller, Carl, "Isokinetics Another Fad or is it Here to Stay?," The Athletic Journal, 55:20, 74-75, November, 1974.

Pickens, Boyd, "Weight Lifting and Basketball," The Basketball Clinic, 13:13-15, December, 1980.

Pipes, Thomas V., and Wilmore, Jack H., "Muscular Strength Through Isotonic and Isokinetic Resistance Training," The Athletic Journal, 56:42-45, June 1976.

Polhemus, Russ, "Plyometric Training for the Improvement of Athletic Ability," Scholastic Coach, 51:68-69, November, 1981.

Prins, Jan, "A Physiological Review of Leg Extensor Power and Jumping Ability," Swimming World and Junior Swimmer, 21:28-30, 32, November, 1980. (1)

Raveling, George, War on the Boards a Rebounding Manual, n. pub., n. d., 75 pp.

Riley, Dan, "Time and Intensity Keys to Maximum Strength Gains," Scholastic Coach, 50:64, 66, 74-75, November, 1980.

"Strength Training for Volleyball," in Championship Volleyball by the Experts, pp. 189-204, Edited by Bob Bertucci, Leisure Press, West Point, N.Y., 1979.

Scoles, Gordon, "Depth Jumping! Does it Really Work?," The Athletic Journal, 58:48, 50, 74-76, January, 1978. (4)

Silvester, L. Jay, and others, "The Effect of Variable Resistance and Free--Weight Training Programs on Strength and Vertical Jump," National Strength and Conditioning Association Journal, 3:30-33, December/January, 1981-82.

Stevens, Ron, "Isokinetic vs. Isotonic Training in the Development of Lower Body Strength and Power," in Isokinetic Research, pp. 22-23, MGI Strength/Fitness Systems, Independence, MO., 1980. (1)

Van Oteghen, Sharon L., "Two Speeds of Isokinetic Exercise as Related to the Vertical Jump Performance in Women," The Research Quarterly, 46:78-84, March, 1975.

"Isokinetic Conditioning for Women," in Isokinetic Research, pp. 21, MGI Strength/Fitness Systems, Independence, MO., 1980.

Verhoshanski, Yuri, "Are Depth Jumps Useful?," Yessis Review of Soviet Physical Education and Sports, 3:75-78, September, 1968. (3)

Verkhoshanski, Yuri, "Perspectives in the Improvement of Speed-Strength Preparation of Jumpers," Yessis Review of Soviet Physical Education and Sports, 4:28-34, June, 1969.

Wathen, Dan, "A Comparison of the Effects of Selected Isotonic and Isokinetic Exercises, Modalities, and Programs on Vertical Jump in College Football Players," National Strength and Conditioning Association Journal, 2:46-47, October/November, 1980.

Wilson, Jim, "Isokinetics for Maxi-Programs," The Athletic Journal, 53:39, 91-92, April, 1973.

Wilt, Fred, "Plyometrics What is it--How it Works," The Athletic Journal, 55:76, 89, May, 1975.

Yessis, Michael, "Maximize Your Basketball Players' Jumping Abilities," The Winning Edge, 1:1-2, 10, May-June, 1981.

ADDITIONAL READINGS

Doherty, Ken, "Power Training for the High Jump," Scholastic Coach, 37:12-13, 62-63, March, 1968.

Keller, Val, Point, Game and Match Championship Volleyball Techniques for Players and Coaches, Creative Sports Books, Hollywood, CA., 1968, 97 pp.

Kondrashin, V., and Koryagin, V., "Special Physical Training of Tall Basketball Players," Yessis Review of Soviet Physical Education and Sports, 12:108-111, December, 1977.

Lambert, Randy, "The Slam Dunk Jumping Program," The Athletic Journal, 61:36, 63, September, 1980.

Monkerud, Donald, "The Sky's the Limit," Volleyball Magazine, 57-62, August/September, 1979.

Petrov, V., "How to Develop Jumping Ability," Yessis Review of Soviet Physical Education and Sports, 13:6-8, March, 1978.

Sanchez, Henry, "The Science of Jumping in Basketball," The Basketball Clinic, 12:5-7, April, 1980.

Scates, Al, "Volleyball (Basketball) Jump Training at UCLA," Scholastic Coach, 48:24-25, May/June, 1979.

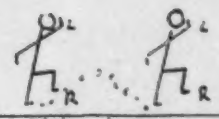
Van Harless, Roger, "How to Improve Your Players' Jumping Ability," The Basketball Clinic, 12:9-10, December, 1979.

APPENDIX

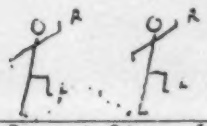
APPENDIX

Plyometric Exercises

Step 1 (left): Stand in place, driving left arm up and forward and right thigh up and parallel to ground. Step 2 (right): Hop vertically in place, concentrating on arm drive and opposite thigh drive.

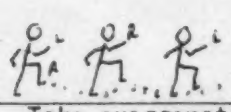


Step 3: Skip down runway; driving left arm up and forward and right thigh up to parallel. Land on left foot each time. Take mini-step to regain balance, then repeat for 30-40 meters.



Step 4: Repeat Steps 1 to 3 with right arm drive and left knee.

Step 5: Alternate skips with following foot pattern--LL, RR, LL, RR, LL. Continue for 30-40 meters.

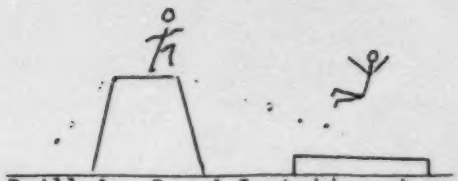


Step 6: Take exaggerated steps, concentrating on driving arm high and thigh up and parallel to ground. Stress drive off ground with rear leg.

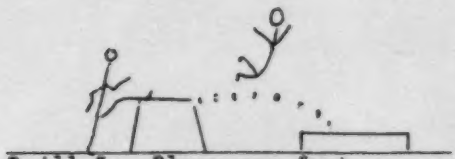
Drill 1: Jump from box to ground and back to top of other box on one leg.

Drill 2: Use both feet together to jump from top of one box to top of other box.

Drill 3: Jump from high box to ground, then to lower box on one leg.



Drill 4: Run 4-5 strides, jump to top of box and spring to mat.



Drill 5: Place one foot on box and, from this standing position, thrust yourself up and over the mat.

Drill 6: Place hurdles a yard apart on a mat, then: (a) hop on right leg over each, (b) hop on left leg over each, (c) jump over with both.

Bounding and Depth Jump Workouts:

Beginners: One session per week, all bounding on a rubber mat, 20-30 jumps per session in sets, with running and relaxation between sets.

Example of a Tuesday workout:

3 x Steps 1, 2, 3 (with each leg over 30 meters)
3 x Step 5 (over 50 meters)
3 x Bounders (over 30 meters)

Intermediate: Two sessions per week, bounding and depth jumping on a rubber mat, 15-30 jumps per session in sets, with running and relaxation between sets.

Example of Tuesday and Thursday workouts:

2 x Step 5 (over 30 m.)
3 x Bounders (over 50 m.)
3 x 1-1-1-1 boxes (Box Drill 6)

Advanced: Two or three sessions per week, 20-40 jumps per session with running and relaxation between sets.

Example of Tuesday, Thursday, and Saturday workouts:

5 x Bounders (over 50 m.)
5 x 1-2 boxes (Box Drill 1)
5 x 2-1 boxes (Box Drill 3)
5 x Double Leg Drop (Box Drill 2)"[1]

"Jump Training

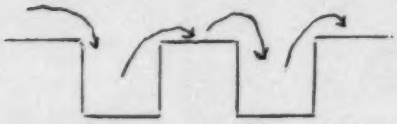
1. SKIPPING - rope goes twice around with each jump.
   - 50 times (first month) then, 100, 150, etc.

2. HLF SQUAT - 10 times quickly with a person on your back.
   1st month - 10 times x 3 sets
   2nd month - 10 times x 5 sets
   etc. - 10 times x 7 sets

3. BACK RAISES - 10 x 3 - 10 lbs. - weight held in hands behind head.
   10 x 5 - 15 lbs. - (2nd month)
   10 x 7 - 10 lbs.

4. ZIG-ZAG JUMP OVER ELASTIC - 10 times at knee height continuously, then 10 times at waist height non-continuously.

5. JUMPING UP AND DOWN - with boxes or benches.



   3 sets x 10 times with 10 lbs. in hand
   5 sets x 10 times with 15 lbs.
   7 sets x 10 times with 20 lbs.

6. ARM ACTION FOR JUMP - hyperextension with weights.

   1st month - 10 x 3 - 10 lbs.
   2nd month - 10 x 5 - 15 lbs.
   3rd month - 10 x 7 - 20 lbs. *Then spike 1-2 hundred times.

7. SPLIT JUMPS

   Routine: Jumping and landing with one foot in front of the other. Repetitions 4 x 12.

8. BENCH JUMPS

   Off and on to another with weight. The weight should not be more then 50 to 60 lbs.

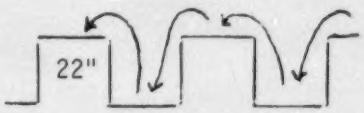
---

[1]Mann, Ron, "A Plyometric Progression to Meet the Athlete's Needs," Scholastic Coach, pp. 51-2, 55.

Routines:

Jump as in the diagram and then walk back and repeat. Note: When you come down from the high one you should rebound right up to the next one which is low.

Repetitions 3 x 6



9. VERTICAL JUMP (jump reach)

   Routine: Hold dumbbell in one hand while you jump and reach with the other one. Repetitions: 3 x 10

10. SKIPPING Use ankle weights, or weight jacket.

    Routine: Go for a set distance, (a lap of the gym). Use a weight that you can handle easily. Move fast and pick up your knees.

11. HOPPING ON THE SPOT

    Use a weight that you can handle. Do it very fast for 30 seconds, you will have to vary the time and sets depending on your conditions. Set a time and stick with it--FAST! FAST! FAST!

12. BUNNY HOPS (with dumbbell) - Go for 15 meters (50 feet). Walk back and repeat. Repetitions 3 to 8."[2]

---

[2]Toyoda, Hiroshi, "Jump Training," in Championship Volleyball by the Experts, Edited by Bob Bertucci, Leisure Press, West Point, N.Y., 1979, pp. 209-210.